Saskatchewan
Ministry of
Environment

ISO 14001
REGISTERED

# Dwarf Mistletoe Management

***TURN IN POACHERS***

www.sasktip.com
**1-800-667-7561**
**24 Hours Toll Free**
saskturninpoacher@serm.gov.sk.ca

for copies of this report, contact:

Forest Service
Saskatchewan Ministry of Environment
Box 3003 Prince Albert, SK
Canada S6V 6G1
ph. (306) 953-2221
fax. (306) 953-2360

Or visit our web site at:
www.environment.gov.sk.ca

## Table of Contents


**1.0 Introduction ..... 1**
1.1 Objective ..... 1
1.2 Applicability of Dwarf Mistletoe Management Standards ..... 2
**2.0 Detection Surveys and Evaluation: Incidence, Extent & Severity ..... 2**
2.1 Landscape-level Assessment. ..... 2
2.2 Aerial Survey and Assessment. ..... 2
2.3 Stand-scale Survey and Assessment. ..... 5
2.3.1 Severity. ..... 5
2.3.2 Incidence. ..... 5
**3.0 Stand-Level Survey Procedures ..... 6**
3.1 Survey where wood supply is not primary objective ..... 6
3.2 Survey where wood supply is the primary objective ..... 6
3.2.1 Strip sampling walkthrough field procedure ..... 7
3.2.2 Assess Severity (proportion of DMT broom in crown) ..... 7
**4.0 Dwarf Mistletoe Management Strategies ..... 7**
4.1 Prevention of infection in future stands ..... 7
4.2 Use of Buffers ..... 8
4.3 Suppression of infection in existing stands ..... 10
4.3.1 Clearcutting ..... 10
4.3.2 Overstory removal ..... 10
4.3.3 Pruning ..... 11
4.3.4 Fire ..... 11
4.4 No management ..... 11
**5.0 Assessment of Dwarf Mistletoe Treatment Areas ..... 11**
5.1 Free - to - Grow Status ..... 11
**6.0 Dwarf Mistletoe Management in Protected and Special Use Recreational Areas ..... 12**
6.1 Riparian Areas ..... 12
6.2 Representative Areas ..... 13
6.3 Recreational, spiritual, and other land-use values ..... 13
**7.0 List of References ..... 15**

## List of Figures

Figure 1. Conceptual dwarf mistletoe survey and data collection process ..... 4

Figure 2. Hawksworth Six-Class Rating System (Anon. 1995)..... 5

Figure 3 Strip sampling design to ground-truth severity and extent of dwarf mistletoe. ..... 6

## Acknowledgements

The dwarf mistletoe management project committee was composed of representatives from government and industry. Individuals on the committee, and others involved in reviewing supporting documents and previous versions of this document, include:

Earl Bourlon, Saskatchewan Environment
Chris Brown, Saskatchewan Environment
Ann Gerry, Saskatchewan Environment
Wilf Goerwell, Saskatchewan Environment
Sandra Jewell, Saskatchewan Environment
Adam Kosowan, Saskatchewan Environment
Tim Loran, Saskatchewan Environment
Pat Mackasey, Saskatchewan Environment
Michael McLaughlan, Saskatchewan Environment
Robert Moore, Saskatchewan Environment
Gigi Pittoello, Saskatchewan Environment
Beatrice Regnier, Saskatchewan Environment
Jim B. Smith, Saskatchewan Environment
John Thompson, Saskatchewan Environment
Bruce Walter, Saskatchewan Environment
Deb Weedon, Saskatchewan Environment
Keith Knowles, Manitoba Conservation
Alex Woods, British Columbia Ministry of Forests
Dr. James Brandt, Canadian Forest Service

# 1.0 Introduction

The purpose of this document is to present standards and guidelines of conduct aimed at ensuring the efficient and effective management of dwarf mistletoe *Arceuthobium americanum* Nutt. ex Engelm. (Dwarf mistletoe or mistletoe). This document will be incorporated into the Forest Planning Manual, in accordance with section 19 of The Forest Resources Management Act 1999 (FRMA). While recognizing that dwarf mistletoe is an integral component of the boreal forest, it is the intent that the dwarf mistletoe management standards and guidelines document will provide a framework for managing the extent and severity of this pathogen in forests on Crown Resource Land as defined under FRMA. This document also follows the commitment to manage fires and forest insects and diseases in Saskatchewan as articulated in the 2000, Saskatchewan Environment (SE) provincial policy framework document[1].

As such, this document will set minimum, measurable standards that ensure management actions are conducted in an ecologically, and economically feasible manner. The provincial standards, guidelines and procedures for assessing and managing dwarf mistletoe in Saskatchewan's provincial forests (hereinafter referred to as dwarf mistletoe management standards) will be reviewed and amended to ensure that most recent science is incorporated into the document. This information will become a section of the Forest Planning Manual, addressed under Forest Health Surveys and Management.

## 1.1 Objective

The dwarf mistletoe standards will incorporate the following directions and objectives as they are developed on the basis of a thorough review of published literature and current dwarf mistletoe management activities, policies and standards within all jurisdictions throughout the natural range of dwarf mistletoe. The initial standards will be generic and achievable, and based on current practices and science. The main objective is to implement measurable standards that will be reviewed and updated, as necessary, so that the process can remain adaptive through the incorporation of new information as, and when, it becomes available.

Specific objectives of this document for determining and establishing provincial objectives for managing dwarf mistletoe include;

---

1 SE's Fire and Forest Insect and Disease Policy Framework
http://www.se.gov.sk.ca/fire/pdf/Fire%20and%20Insect%20Policy.pdf

- Developing baseline standards and guidelines for dwarf mistletoe management practices associated with Saskatchewan's provincial forests;
- Standardizing survey procedures that will be used to assess the severity and extent of dwarf mistletoe;
- Developing measurable standards that will ensure the success of dwarf mistletoe management practices leading to improved regeneration in Saskatchewan's provincial forests;
- To improve understanding of dwarf mistletoe and increase forest industry accountability for dwarf mistletoe management and reforestation in Saskatchewan.

### 1.2 Applicability of Dwarf Mistletoe Management Standards

The purpose of this document is to provide a framework to define science-based ecologically acceptable, and measurable, standards to be applied as targets. These management targets must meet or exceed predetermined goals for ensuring the effects of dwarf mistletoe on values at risk are minimized. These guidelines have been developed outlining strategic and tactical approaches on the basis of published scientific knowledge and a thorough review of activities in other jurisdictions. The focus of these guidelines is to ensure ecologically sound, practical and operationally feasible protocols to help guide the implementation of dwarf mistletoe management activities.

## 2.0 Detection Surveys and Evaluation: Incidence, Extent & Severity

### 2.1 Landscape-level Assessment.

Detection surveys provide landscape-level information critical to the development of forest management plans. These data can be used to identify areas where significant dwarf mistletoe action will be needed and typically are used to plan and integrate actions into operational activities over the landscape. This broad overview follows the conceptual approach shown in Figure 1.

Landscape level assessment of the extent and severity of dwarf mistletoe may be conducted using remote sensing, or using other satellite, remote or airborne technology or techniques as appropriate.

### 2.2 Aerial Survey and Assessment.

Landscape-level assessment of dwarf mistletoe can be achieved by using systematic aerial survey. Surveys can be conducted using fixed or rotary wing aircraft. Aerial surveys should be conducted in a systematic manner flown a'ong parallel flight lines 1.6 km apart,

at a recommended height of about 150-200 meters m above ground level. Appropriate aircraft should be selected to achieve low-level flight as well as ability to fly at 100-115 km/hr as described by Baker *et al.* (1992). Aerial surveillance is best conducted during winter to take advantage of the contrast between dark dwarf mistletoe brooms and snow-covered ground. Stands can be surveyed visually from the air and areas of mistletoe infection delineated and transcribed to national topographic survey maps at the scale of 1:50,000. Areas identified through aerial survey should be verified and further classified using ground reconnaissance techniques. Ground-based verification could also be achieved during routine pre-harvest silvicultural prescription (PHSP) surveys or during annual cut-block layout.

Landscape assessment of mistletoe incidence can also be quantified using the disturbance assessment procedures outlined in the Saskatchewan Forest Vegetation Inventory (SFVI) Document standards which is part of the Forest Planning Manual. Infected areas can be delineated from 1;15,000 aerial photographs and the extent of dwarf mistletoe identified as disturbances. Area of polygons covered by dwarf mistletoe can then be classified using the disease feature and the extent coded on the basis of percentage of polygons covered by mistletoe.

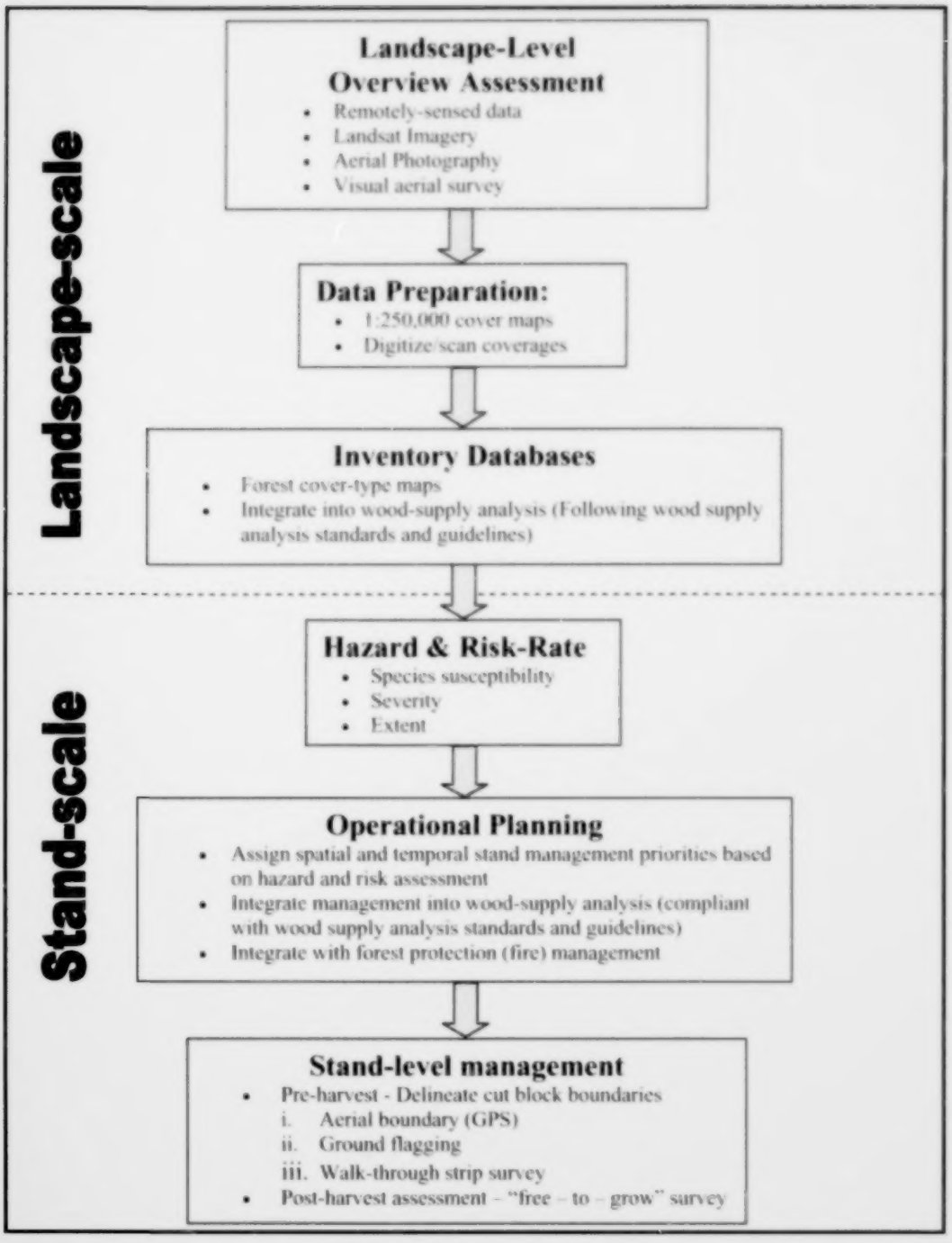


**Figure 1. Conceptual dwarf mistletoe survey and data collection process**

### 2.3 Stand-scale Survey and Assessment.

Following remote sensing or aerial reconnaissance activities, the incidence and severity of dwarf mistletoe can be easily verified on the ground. The number and distribution of witches brooms can be used to determine the presence and severity of dwarf mistletoe infections. Where dwarf mistletoe has been noted, stand level information can be collected to determine the severity and distribution of the infection at the stand level.

#### *2.3.1 Severity.*

A broadly accepted approach to quantifying severity is the Hawksworth six-class dwarf mistletoe rating system (Hawksworth 1977) as described in Figure 2. Stand level assessment is determined as an average rating of all infected trees. Both tree and stand level severity rating is assessed as follows:

1-2 = low;
3-4 = moderate; and
5-6 = high.

#### *2.3.2 Incidence.*

Incidence of infection is calculated as the proportion of susceptible trees infected in the stand. In addition to mistletoe severity and incidence, factors, such as presence and extent of other insects and diseases that might influence silvicultural prescriptions, should also be recorded.

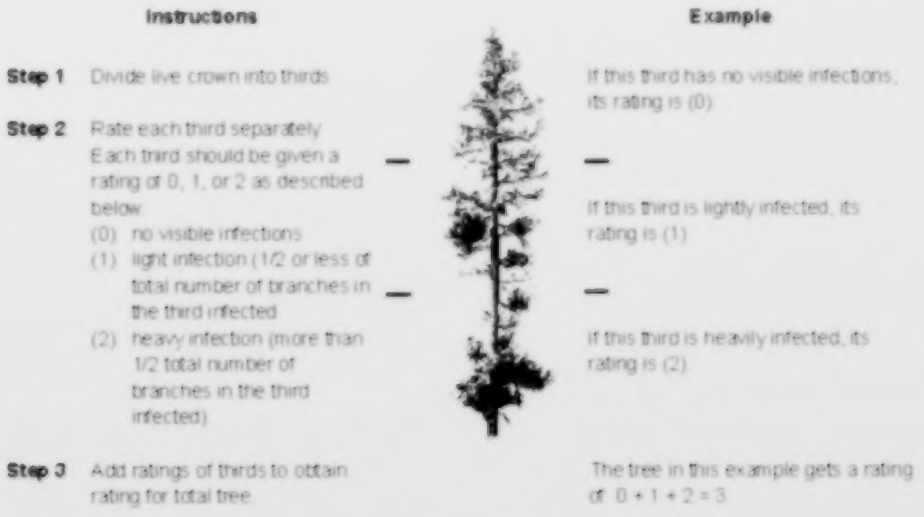
Instructions
Example
Step 1
Divide live crown into thirds
Step 2
Rate each third separately
Each third should be given a rating of 0, 1, or 2 as described below
(0) no visible infections
(1) light infection (1/2 or less of total number of branches in the third infected
(2) heavy infection (more than 1/2 total number of branches in the third infected)
If this third has no visible infections, its rating is (0)
If this third is lightly infected, its rating is (1)
If this third is heavily infected, its rating is (2)
Step 3
Add ratings of thirds to obtain rating for total tree
The tree in this example gets a rating of 0 + 1 + 2 = 3

**Figure 2. Hawksworth Six-Class Rating System (Anon. 1995).**

# 3.0 Stand-Level Survey Procedures

## 3.1 Survey where wood supply is not primary objective

An approved methodology for surveillance is to conduct a survey quantifying the presence or absence of dwarf mistletoe. In protected areas or areas where protection of wood supply is not the primary management objective, severity of the infection can be quantified using the Hawksworth Six-Class rating system, Figure 2. Typically, this method allows for detailed stand-level assessment of severity and extent to be made for use in selecting the most appropriate management response given the specific land use objectives.

## 3.2 Survey where wood supply is the primary objective

Survey in forest areas designated for harvest can be conducted during pre-harvest site prescription (PHSP) surveys or during operational cut-block layout. As the stand is flagged for harvest, it should be assessed to quantify the extent and severity of DMT incidence in the stand. Using this method, it is recommended that a minimum area of 1% of the total stand area should be surveyed.

Walkthrough strip sampling is the recommended sampling and survey technique. In this survey methodology, a line-transect survey, Figure 3, should be conducted using the field procedures below.

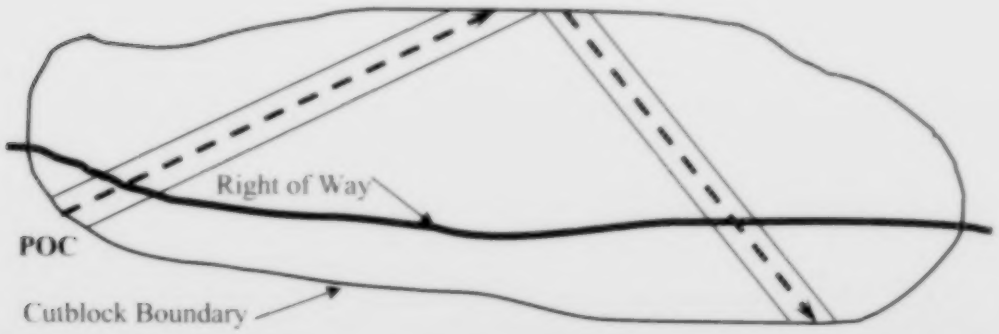


**Figure 3** **Strip sampling design to ground-truth severity and extent of dwarf mistletoe.**

### *3.2.1 Strip sampling walkthrough field procedure*

1. Create large-scale map 1:10,000 as described in the SFVI standards.
2. Randomly select point of commencement (POC) on cut-block edge.
3. Draw transects on map – use global positioning systems (GPS) to establish a continuous 10 meter wide cruise-line strip.
4. Flag all lineslong each transect and record:
   i. Total number of infected trees
   ii. Number uninfected host trees
   iii. Severity rating (see below)
5. Calculate % incidence:
   Percent incidence can be quantified using the formula below:

$$\textit{Percent Incidence} = \left( \frac{\text{Total Infected}}{\text{Total Surveyed}} \right) \times 100$$

### *3.2.2 Assess Severity (proportion of DMT broom in crown)*

1. Heavy = 50%+ brooms in crown
2. Moderate = 20-49%
3. Light =10-19%

## 4.0 Dwarf Mistletoe Management Strategies

Choice of management action should be determined on the basis of land use management objectives for the management unit. Tactics can be implemented at the stand level on a stand-by-stand basis, but integrated with multiple land use criteria and planned on a landscape level. The following management options may be used:

1. Harvest and regenerate the stand
2. Prescribed burn and regeneration
3. Overstory removal
4. Commercial thinning
5. Residual removal
6. Pruning
7. Do nothing
8. Create buffers
9. Use non-host species

Dwarf mistletoe management strategies can take the form of ***prevention*** of further infection in non-infected future stands; or ***suppression,*** which involves active control to reduce the extent and severity in existing infected stands.

### 4.1 Prevention of infection in future stands

Prevention should be given high priority. It is far more efficient to prevent the spread and establishment of mistletoe in non-infected stands than to remove it from infected stands or to replace severely infected stands. New stands will become re-infected if sources of the

dwarf mistletoe seed remain on or within range of susceptible host trees. Tactics to limit re-infection should be implemented. This can be achieved through timely removal or control of infected residual trees; manipulating the size and shape of the cut-block and by considering conditions in adjacent stands.

**Provincial Standards for preventive techniques are**:

1. **Sanitation - Ensure all living infected trees are removed during harvest and sanitation operations. After cutting, all susceptible advance regeneration taller than 1 m, should be cut and/or killed. All non-host residuals and advanced regeneration may be left standing.**
2. **Buffers - If the cut block is to be regenerated with susceptible species, a minimum buffer of 20 meters between residual infected stands and new regeneration must be established and maintained (see Section 4.2).**
3. **Residual removal - Re-infection of new regeneration in stands infected by mistletoe, which have been killed by natural disturbances such as fire, must be restricted. Infected residual trees located in the burned area or in residual patches and islands must be killed.**

Provincial guidelines include:

1. Natural barriers. - Leave non-host residuals on the edges and incorporate "natural barriers" such as lakes and roads.

2. Minimize "edge"- Reduce the edge to area ratio. Ensure cut-blocks are regular in shape; avoid strip cuts.

### 4.2 Use of Buffers

***Buffers***

In situations where acceptable natural barriers are absent, seed dispersal and the spread of dwarf mistletoe can be limited significantly through the use of a buffer system. Buffer zones can comprise cleared strips of land, devoid of susceptible vegetation, or zones planted with non-host species. In Saskatchewan, the required buffer width is 20 meters from the edge of the contiguous forest to the edge of the newly regenerated area. This distance is consistent with published seed dispersal research (Baranyay and Smith 1972; Hawksworth and Wiens 1996).

***Cleared buffers***

Should be cleared, and maintained clear, of susceptible host species to remove connection to adjacent infected stands. These should be considered to be "temporary" cleared areas that might be regenerated with jack pine at the time the adjacent infected stand is cut.

***Planted buffers***

Selection of non-host species for planting in buffers must be suited to the site criteria and should be prioritized as follows:

1. Species, whose natural range includes the boreal forests of Saskatchewan, should be considered first;
2. Non-host species that might enhance fire-break values;
3. Other boreal species may be considered subject to the following conditions:
   i. After planting for the specific purpose of mistletoe management, buffered areas should be monitored for performance, pest incidence and severity; and
   ii. If soil stability is compromised and none of the criteria in bullets 1 and 2 above, can be achieved.

Objective #1: To limit seed dispersal and subsequent spread and infection of dwarf mistletoe into adjacent susceptible stands where adjacent stands are:

(a) harvested or silviculturally treated, and
(b) outside of ecological reserves, representative areas, provincial parks and other protected areas.

**Provincial Standard:**

1. **Buffer width shall measure 20 meters between infected adjacent stand and susceptible regeneration.**
2. **Buffers shall be maintained clear of susceptible species for a ten (10) year period during which time the regenerated cut block will have grown sufficiently to reduce the risk of reinfection from volunteer trees in the buffer zone.**

Provincial Guidelines:

1. Where newly regenerated areas border non-merchantable jack pine stands infected with dwarf mistletoe, other approved species not susceptible to dwarf mistletoe, should be considered for regenerating the 20 meter buffer zone;
2. Where newly regenerated areas border merchantable jack pine stands a progressive harvesting strategy should be implemented until all adjacent infected merchantable jack pine stands are harvested.
3. Activities, such as site preparation, which might stimulate regeneration of susceptible species should be avoided within the 20 meters buffer zone.

### 4.3 Suppression of infection in existing stands

Plans to limit the spread of mistletoe in existing stands and to reduce the risk of infection to susceptible regeneration should be an integral component of the pre-harvest silvicultural prescription process (data collected during the pre harvest site prescription and then used to develop the silvicultural plan). Management in existing stands should focus on eliminating the source of dwarf mistletoe and containing infected areas. Mistletoe spread in existing stands can be limited through the following silvicultural approaches.

#### *4.3.1 Clearcutting*

Clearcutting is the most effective harvest system to ensure sanitation. This is the recommended system in all infected areas where timber production is of significant importance. Cut blocks should exceed 10 hectares.

Objective #2: To remove the source of dwarf mistletoe spread and infection into regeneration. Infected living trees that contain living dwarf mistletoe, and a viable seed source, must be killed to reduce the risk of infection in new regeneration.

**Provincial Standard:**

1. **In harvest blocks, or portions of harvest blocks containing jack pine infected with dwarf mistletoe, all living jack pine greater than 1 metre in height shall be felled or killed within 100 metres of the infected area, within the planned block boundary. On harvest block perimeter edges where infected pine exists in inoperable areas (i.e. soft ground or steep slopes), the licensee may choose to use 2 (below). Maps and PHSPs clearly indicating where the portions of the infected areas will be submitted to SE as part of the approval process.**
2. **Upon block harvest completion, no jack pine shall be planted within 20 meters of an adjacent stand infected with dwarf mistletoe. If progressive harvesting strategy is used these areas must be regenerated. Alternatively, other species suitable for the site may be planted in this zone.**
3. **Live residual trees that are susceptible to dwarf mistletoe and have been left for retention values must be clear of visible infection.**
4. **Infected trees may be left standing for retention values provided they are killed.**
5. **Trees left standing shall be left in a manner that ensures a safe work site consistent with <u>The Occupational Health and Safety Act.</u>**

#### *4.3.2 Overstory removal*

This approach might be used to manipulate stand structure by converting a multi-aged stand to an even-aged stand. This approach is not recommended on forest land subject to a commercial license and included in the timber supply. Over-story removal might be considered in environmentally sensitive or protected areas.

**Provincial Standard:**

1. **All infected over-story and under-story trees must be removed.**

#### *4.3.3 Pruning*

Pruning may be conducted in environmentally sensitive areas or areas where timber management is not the land use priority. This method does not ensure sanitary conditions and continual efforts are required. This method is only effective subject to the following considerations:

- Prune in **lightly infected** stands <15 years old.
- Heavily infected trees should be removed first.
- Trees >50% crown infected should not be pruned.
- Do not prune if infection is less than 10 centimetres from tree stem.

#### *4.3.4 Fire*

Wherever possible, and subject to all applicable Fire Management and Forest Protection (FMFP) policies, standards and guidelines, wildfires should be allowed to restore or enhance ecological values through allowing wildfires to sanitize severely infected stands. Severely infected stands should be identified and integrated into the management planning and implementation process when prioritizing fire protection planning within the framework of the appropriate Fire Management and Forest Protection policies, standards and guidelines. Prescribed burning may be considered as a tool to sanitize severely infected stands and restore forest health. Following treatment, areas should be regenerated or restored in compliance with provincial stocking levels and regeneration and dwarf mistletoe standards and guidelines.

### 4.4 No management

A "do nothing" scenario might be considered in areas where land use values, other than timber production, are a priority.

# 5.0 Assessment of Dwarf Mistletoe Treatment Areas

### 5.1 Free - to - Grow Status

Where mistletoe-infected trees have been removed from an area through harvesting, that area should be restored, to acceptable stocking levels, using species best suited to the site. Newly regenerated areas of susceptible species must be established free of dwarf mistletoe and shall be in compliance with or exceed the following regeneration standards.

Objective #3: The objective of follow up surveillance and assessment is to ensure removal of dwarf mistletoe from the site following dwarf mistletoe management action. Follow-up surveys reveal and allows for the removal of infected trees or advanced regeneration that may not have been identified in the initial action.

**Provincial Standard:**

1. **Sites where dwarf mistletoe management has been implemented shall be free of visible signs of mistletoe infection (such as brooms or aerial shoots) at the time of the first post-harvest silvicultural assessment.**
2. **Susceptible tree species shall not be considered successfully regenerated if:**
    i. **Any tree shows signs of stem infection;**
    ii. **Trees <2 metre tall show signs of branch infection;**
    iii. **Trees >2 metre are infected in the top half of the crown; or**
    iv. **Any susceptible tree is growing within 20-metre radius of any living infected over-story or residual tree.**

# 6.0 Dwarf Mistletoe Management in Protected and Special Use Recreational Areas

## 6.1 Riparian Areas

For the purposes of dwarf mistletoe management, existing operational requirements may be relaxed in sensitive areas such as riparian zones.

**Provincial Standard:**

1. **To limit spread from riparian areas into adjacent susceptible regeneration, mistletoe management activities should only occur within the outer 20 metre area, this area is to be identified in the operating plan submissions;**
2. **Cut only infected susceptible species;**
3. **Infected trees may be killed and left standing dead;**
4. **No falling operations are acceptable in sites where such activities might compromise water quantity and quality values. In these sites mistletoe-infected trees may be killed and left standing or a buffer is recommended; and,**
5. **No trees will be felled into the water body.**

### 6.2 Representative Areas

Representative areas (RA's) are created and established pursuant to The Ecological Reserves Act and The Representative Area Ecological Reserves Regulations. Representative areas are legally designated ecological refuges where the policy is to allow natural disturbance patterns to continue unaltered. In general, Representative Areas are selected using landform or enduring features criteria with the objective of conserving native biodiversity and serving as ecological benchmarks. Thus, **mistletoe management activities are not permitted inside established RA's unless** the roles and objectives of the representative area are threatened. Representative area management policies and guidelines are presented in the *Management and use of Representative Areas Designated as Ecological Reserves document* (Anon 2002).

Within Representative Area and Ecological reserves, the following guidelines are recommended:

1 Whenever possible native insects and diseases should be allowed to proceed through their natural cycles;
2 Management action may occur where exotic or introduced insects and diseases threaten the ecological integrity of native ecosystems; or
3 Where non-intervention threatens to alter native communities through species conversion.

For details in management areas near to or adjacent to Representative Areas, the local Concept Management Plans should be consulted. The following link provides information on each of the designated sites, acceptable uses, prohibited uses and a general map of each of the areas: http://www.se.gov.sk.ca/ecosystem/sran/.

### 6.3 Recreational, spiritual, and other land-use values

Mistletoe management tactics in areas that, through the Integrated Forest Land Use Planning process, have been assigned values other than timber, must be reviewed and integrated into the overall land use plan. Appropriate tactics might include any of the nine identified in Section 4.0 of this document, either singly or in combination, depending on a comprehensive assessment of the values at risk.

Objective #4: The objective is to limit the spread of dwarf mistletoe from protected areas (including ecological reserves, representative areas, provincial parks and recreation sites) into adjacent regeneration in areas susceptible to increased incidence and severity of dwarf mistletoe, while considering significant values at risk and maintaining ecological values in the forest.

**Provincial Standards:**

1. **For the purposes of dwarf mistletoe management, only infected susceptible species can be cut or killed and left standing dead;**
2. **Infected trees within the 20-metre zone may be harvested, subject to review and approval of the Area Forester, or killed and left standing.**
3. **Intervention may be permitted in Representative Areas if the mistletoe infection threatens to convert an area of Jack pine to open grass or shrubs, or if elevated fire risk threatens human safety or adjacent forest values at risk.**
4. **Establish a 20-meter buffer zone. The buffer should be maintained clear or regenerated with non-host species, following buffer zone guidelines.**
5. **No falling operations are acceptable in sites where such activities might compromise water quantity and quality values. In these sites mistletoe-infected trees may be killed and left standing or a buffer is recommended.**
6. **No trees will be felled into the water body.**

Provincial Guidelines:

1. If adjacent stands contain mixed species, comprised of host and non-host trees, remove all susceptible host trees within a 20-metre distance of the boundary of the RA and encourage non-host regeneration.
2. Management in Representative Areas is permitted to protect ecological integrity. The following guidelines should be followed:
   - Whenever possible native insects and diseases should be allowed to proceed through their natural cycles;
   - Management action should be considered where non-intervention threatens to alter native communities (for example Jack pine forests altered to shrub or grassland).
3. Dwarf mistletoe within areas subject to the Integrated Forest Land Use Planning process shall be addressed in the plan.

## 7.0 List of References


Anon. 1995. Dwarf Mistletoe Management Guidebook. BC Ministry of Forests. Queens Printer for British Columbia, Victoria B.C. 20 pp.

Anon. 2002. Management and use of Representative Areas Designated as Ecological Reserves. 2002. Saskatchewan Environment Internal Government Document. July 2002. 4 pp.

Baker, F., Slivitsky, M., and Knowles, K. 1992. Impact of dwarf mistletoe on jack pine forests in Manitoba. *Plant Disease* **76:**1256-1259.

Baranyay, J.A., and Smith, J.A. 1972. Dwarf mistletoes in British Columbia and recommendations for their control. Report BC-X-72. Canadian Forestry Service, Pacific Forest Research Centre, Victoria B.C. 18 pp.

Hawksworth, F.G. Jr., 1977. The 6-class dwarf mistletoe rating system. General Technical Report RM-48. Fort Collins, Colorado. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 7 p.

Hawksworth, F.G. Jr., and Weins D. 1996. Dwarf Mistletoes: Biology, Pathology, and Systematics. USDA Forest Service Agriculture Handbook 709. 410 pp.